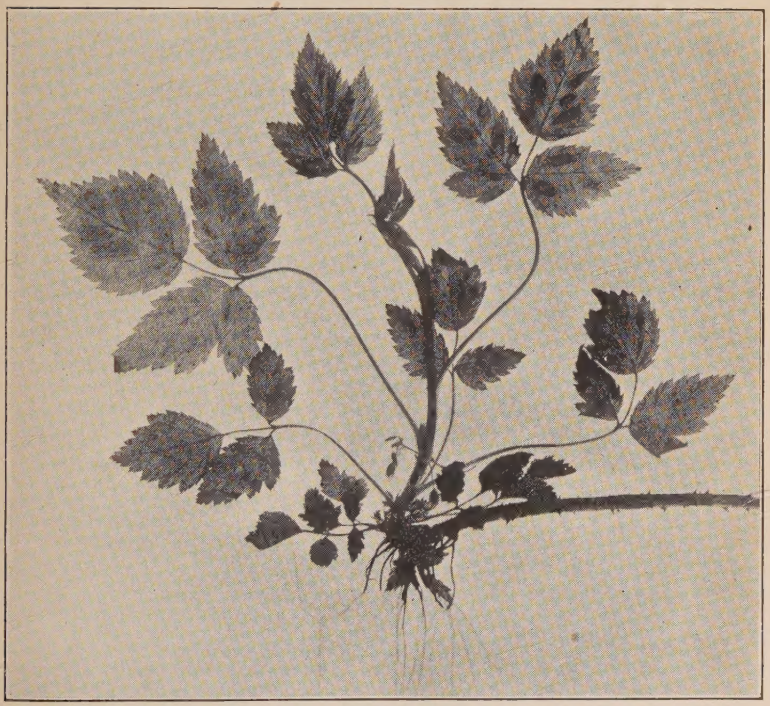
Station Circular 49 July, 1923.

Oregon Agricultural College

Experiment Station

Mosaic and Other Systemic Diseases of Brambles in Oregon

By
S. M. ZELLER



Black raspberry tip showing mosaic symptoms. Such systemic diseases are carried in the transplants. Use stock from disease-free plantings

CORVALLIS, OREGON

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Mosaic and Other Systemic Diseases of Brambles in Oregon

By

S. M. ZELLER

INTRODUCTION

The adaptability of Western Oregon to the successful growing of berry fruits of all kinds has long since been demonstrated. Throughout the berry-growing districts of the Northwest, however, the growers of loganberries and red and black raspberries have realized for a number of years that their plantings were on the decline. In many districts of Oregon and Washington this running-out of yards has made inroads on production, not only reducing the crops, but shortening the life of the plantings until from three to five years after the first appearance of the malady many plantings are useless.

Due to the fact that no funds have been available for the investigation of small fruits the Oregon Experiment Station has not been able to study the history and cause of this decline in berry production in Oregon. During the early spring of 1923, however, the growers of certain berry-growing districts where great losses had occurred made extremely urgent requests for help. As a result of these requests part of the writer's time was given to a survey of conditions in berry yards of Western Oregon. It was soon realized that the growers are confronted with a group of diseases of brambles for which no fungous or bacterial organism has been found although this type of diseases has been studied elsewhere for many years. These plant disorders are not often recognized as diseases, since their symptoms are different from those usually sought in connection with fungous or bacterial diseases of plants. These diseases have become known as **systemic, infectious diseases** since they devitalize the whole system of the plant and are more or less readily transmitted from one plant to another. The infecting principle is in the plant juices, or blood, so to speak.

BRIEF HISTORY OF SYSTEMIC DISEASES OF BRAMBLES

Such diseases of brambles have been known for about twenty-five years. In 1902 Stewart and Eustace[1] of the New York Experiment Station at Geneva described what they called "raspberry yellows" because the disease had similar effects to those produced in peach trees by the disease known as "peach yellows." At that time in the Hudson River Valley the growers of the Marlboro red raspberry complained that they could not raise this variety, which was said to be running out. Among other varieties the Perfection, Empire, and Cuthbert have been tried in succession in the same districts, but each in due time ran its course of a few years. The history of the industry in large fruit-producing areas of other states reads the same.

[1] Stewart, F. C., and H. J. Eustace. Raspberry cane blight and raspberry yellows. N. Y. Agri. Exp. Sta. (Geneva). Bul. 226. See pp. 362-364. 1902.

Recently (1922 and 1923) "raspberry yellows," better known at present as leaf curl, and the mosaic disease of red raspberries, have been described in detail as doing severe damage in Ontario and Quebec.[2] [3]

Found in Northwest Coast States. In the Northwest the running-out of black raspberries has long since taken place in at least one of the most productive berry-growing districts of Western Washington, and at present the Cuthbert and Antwerp red raspberries, loganberries, and several varieties of black raspberries and blackberries have been observed by the writer to be affected with mosaic diseases in several districts of Western Washington. The Marlboro and Cuthbert varieties of red raspberries also show symptoms of leaf curl in these same districts.

Fig. 1. Two loganberry plants showing stages of the mosaic disease. The plant to the right is in the very last stages, showing the rosetted condition of the laterals. The plant to the left is in poor vigor as indicated by the scarcity of new shoots.

In Oregon, yards exhibiting very severe infections of loganberry mosaic were found in a recent survey by the writer in the central part of the Willamette Valley, although the trouble is found in nearly all districts where loganberries are grown. In one of the largest centers of black raspberry production in Oregon many yards are seriously affected with a mosaic disease, while in most districts where red raspberries are grown the mosaic disease is not uncommonly found affecting Cuthberts. Symptoms of leaf curl were also found on Cuthbert and scattering plants of Marlboro and Antwerp varieties, and one planting of black raspberries was found affected with bramble streak (Eastern Blue Stem).

DIFFERENT TYPES OF SYSTEMIC DISEASES IN OREGON

As suggested in the foregoing paragraphs there are evidences of at least three distinct systemic diseases affecting brambles in Oregon. These are **mosaic, leaf curl, and bramble streak.**

The **mosaic disease** as it has been observed by the writer affects *loganberries, blackberries,* and *black* and *red raspberries* in many Oregon plantings. At present we have no evidence against the possibility that the disease

[2] Rankin, W. H., and J. F. Hockey. Mosaic and leaf curl (yellows) of the cultivated red raspberry. Phytopathology 12: 253--264. 1922.

[3] Dickson, B. T. Raspberry mosaic and curl. Sci. Agri. 3: 308--310. 1923.

from one type of berry passes to another type if planted near by. We cannot say, therefore, that there is more than one mosaic disease of brambles in Oregon, although as pointed out in the following paragraphs the symptoms are not the same on all varieties affected.

The **leaf curl** is a disease almost entirely confined to *red raspberries*. This disease is distinct from mosaic although the control of the two diseases and their final effect on the plants are similar. Except on the Marlboro variety the symptoms of leaf curl as observed in Oregon have been rather confusing. Rankin[1] has observed in eastern Canada what he has called mixed infection or plants affected with both mosaic and leaf curl. Many new shoots of the Cuthbert in Oregon plantings have symptoms very much the same as he has described for "suckers which show pronounced mosaic symptoms with slight mixture of leaf curl." (See Fig. 3.)

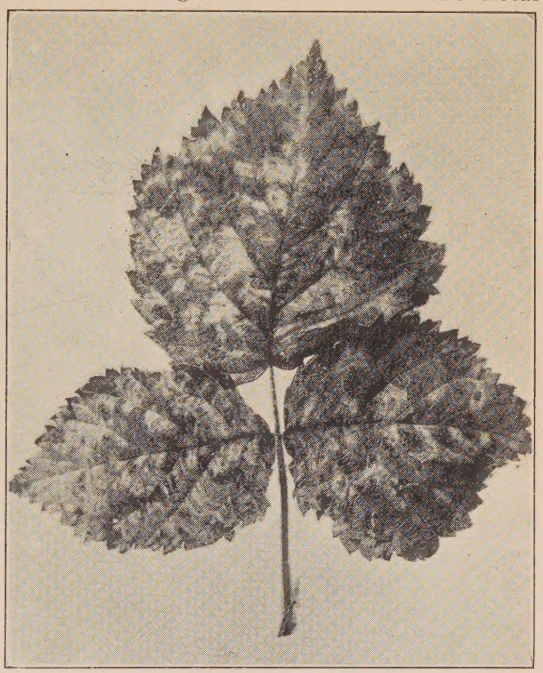

Fig. 2. A pronounced case of mottling of a loganberry leaf affected with mosaic. This is one of the earliest symptoms of the disease.

The bramble streak disease is distinct from mosaic and leaf curl, although the mottling, similar to that found in mosaic, and curled leaves, as found in leaf curl, both occur in bramble streak. This disease, however, is usually confined to *black raspberry*.

The symptoms of these diseases are described very briefly below.

SYMPTOMS OF MOSAIC DISEASES

The most important result of mosaic diseases in brambles is the gradual decline of the plants, which yield sickly fruit and vegetative parts. In three to five years the plants are useless or perhaps dead. The first symptoms are the mottling of the leaves and usually a slightly lighter, yellowish green color of the whole plant. In many varieties of plants these symptoms are accompanied with dwarfing. The mottling of the leaves, caused by lighter and darker areas of green in the same leaf, varies in its prominence due to the thickness and texture of leaf of the affected variety and the weather conditions under which the leaves are formed.

[1] Rankin, W. H. Leaf Curl and Mosaic or Yellows, of the Cultivated Red Raspberry. Interim Rept. Domin. Botanist. Canada Dept. Agric. 1921-1922: 30--60. 1922.

Fig. 3. Diseased tip of red raspberry shoot showing heavy, dark green crinkled leaves and stunted terminal bud which is beginning to cause the growth of the laterals.

The mottling of the **loganberry** leaves is rather masked under usual conditions although at times very distinct mottling occurs, as is shown in Fig. 2. Soon, however, when the darker or healthier portions of the leaf outgrow the lighter parts, a crinkly leaf is produced which is very characteristic. During the spring of 1923 these crinkled leaves have usually appeared near the base of the laterals, for the symptoms are produced during cool weather. Sometimes all the leaves of a cane are crinkly and mottled, and sometimes such abnormal leaves are limited to one lateral. Seldom does the whole plant show these symptoms.

In the diseased **red raspberries** mottled leaves are usually seen on the new shoots produced during cool weather. These have larger splotches of dark green; but in leaves produced during warmer weather the mottling approaches a finer speckling and in hot weather the newly-formed leaves usually show no mosaic symptoms whatever.

In the **black raspberries** the first symptom is the strikingly splotchy mottling of the leaves, especially on the sucker growth and new tips which appear during the cooler spring weather. This symptom is shown in the illustration on the cover of this circular. The leaves of fruiting canes are usually reduced in size and lack the lustre of healthy leaves. Many times the terminal bud and leaves of a cane or lateral may be stunted, thus forcing the development of laterals on the canes or several laterals from one bud. As the disease progresses year after year there is a tendency toward smaller leaves which in black and red raspberries show narrowed leaflets often with deep incisions.

THE NATURE OF MOSAIC

Investigation of mosaic in other plants, as potato, tomato, cucumber, tobacco, etc., has shown that the disease is spread throughout the system of the plant, even though symptoms may be seen on but one portion of the plant. In some cases reported in the East where slight symptoms could be found on only one lateral of a fruiting cane this lateral was removed at once. During the next season, however, all parts of the plant developed the symptoms of the disease. Since every portion of the plant is affected, any tip, shoot for transplanting, or cutting from an infected plant, will carry the disease. Thus, as would be expected, rooted tips of plants affected with mosaic always produce similarly diseased bushes. *It is necessary, therefore, to plant nursery stock which is free from disease, for affected plants do not recover.*

In the mottled leaves of diseased plants only the darker green portions are capable of functioning normally in the manufacture of sugars and starches and in leaf growth. Thus there is insufficient reserve food stored in the roots, and it cannot be expected that such a plant will develop during the second season a leaf surface any larger than that of the functioning portions the year before. During the second year, then, the natural consequence is a smaller number of canes which are dwarfed and bear smaller leaves than do healthy plants. This tendency continues until finally no new canes appear, or perchance one or two develop with weak buds, which unfold very tiny leaves during the next spring and subsequently die during the summer. The laterals of the fruiting canes do not elongate normally, and in the last year of the disease develop merely a rosette of small leaves next to the cane. The tendency here is for the leaves to bronze early or hold into the summer the reddish tinges of very young diseased leaves.

Fig. 4. Healthy plant of Munger black raspberry. Notice the vigorous growth of new canes, a condition which does not prevail in plants affected with mosaic.

SYMPTOMS OF LEAF CURL

Leaf curl of red raspberries, like mosaic, is a systemic disorder and affected plants never recover. The leaves of affected plants have shortened stems, arched and crinkled leaflets, and either an abnormally dark green or light yellow color. The crinkled leaf-surface has an appearance as though the veins are too short for the amount of tissue between them. Usually the main vein of each leaflet is arched or curled downward as also are the leaf margins. For the most part, however, the dark green leaves on new shoots as they have been observed in the West show crinkle due to arching of tissue between all of the small veins, but there is very little tendency for the midveins and margins to curl downward. As the disease progresses the leaves become very small and crinkled; the canes are dwarfed, thick and stocky. The fruiting laterals are upright, dwarfed, and bear curled, heavy, dark green, small leaves. Flowers appear somewhat later than normally, and the fruit is inferior and dry. Although this disease is uncommon, it has been observed on Cuthbert and Marlboro red raspberries in Washington and Oregon.

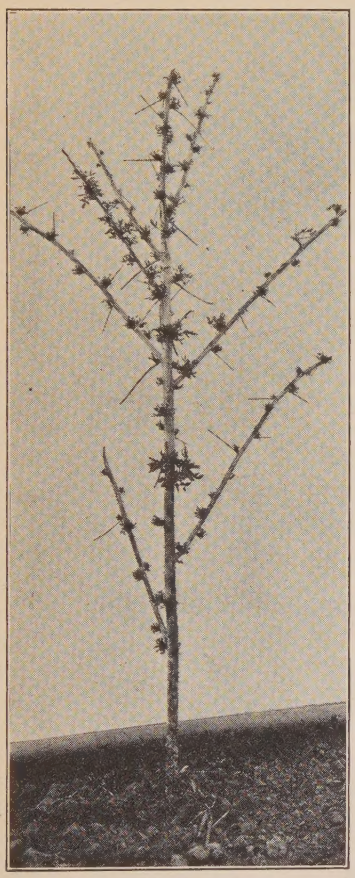

Fig. 5. Munger black raspberry plant in the last stages of the mosaic disease.

SYMPTOMS OF BRAMBLE STREAK

Bramble streak was recently described by R. B. Wilcox[2] of the United States Bureau of Plant Industry under the name of Eastern Blue Stem of the black raspberry. Bramble streak is of the same general type of diseases as the leaf curl of the red raspberries, but it also produces some symptoms like those of mosiac diseases. Although this trouble is widespread and causes much loss in Eastern and Middle Western states, it has been found thus far by the writer in but one planting of black raspberries in Oregon. This disease stunts the bushes and checks their growth. The leaves of diseased plants are curled due to an arching downward of the midveins of the leaflets. This curling of the leaves is most pronounced toward the tips of the fruiting laterals which are shorter than on normal plants. After two or three seasons the leaves on the shortened laterals are crowded and curled, giving a rosette appearance. As in mosaic diseases, there is a uniform mottling of the leaves, which is shown in the accompanying illustration. In some districts in the eastern states there are discolored mark-

[2] Wilcox, R. B. Eastern blue-stem of the black raspberry. U. S. Dept. Agr. Dept. Cir. 227. pp. 1-12. Fig 1-2. 1922.

Fig. 6. Various stages of the mosaic disease on fruiting stems of Munger black raspberry. Notice how the leaves are gradually reduced in size and width, and the laterals become mere rosettes of tiny leaves. Healthy leaf to the left. Insert in upper left hand corner illustrates a common tendency towards deeply incised, narrow leaflets on plants affected with mosaic.

ings and spots on the stems. Dark blue streaks like broad pencil marks run lengthwise of the canes or there may be small spots of the same color more or less crowded, giving the stems abnormally dark blue shades, or there may be *no* discoloration of the stems. Bramble streak is another systemic disease which is transmitted chiefly through diseased tips.

HOW ARE THESE DISEASES SPREAD?

During the survey of disease conditions in loganberry and black and red raspberry plantings of Oregon one fact has been strikingly evident. That fact is: wherever high percentages of the mosaic and leaf curl diseases are found the plantings from which the nursery stock was taken were also sure to be diseased. Since the troubles are diseases of the whole system of the plant, all of the transplants from diseased red raspberries and all rooted tips of diseased loganberry, blackberry, and black raspberry plants will develop into diseased plants. To illustrate: One loganberry grower had three plantings five, three, and two years of age, respectively. The tips of the five- and three-year-old plantings had been taken from an older planting which had died out due to a cause unknown to the owner. The five-year-old planting was about 40 percent infected while the three-year-old showed 72 percent infection. The owner was uninformed as to the trouble in the parent yard, and he evidently chanced to select 60 per cent of healthy tips five years ago but only 28 percent of healthy tips three years ago. The tips for the two-year-old yard were taken from the three-year-old yard, which was 72 percent diseased, and this selection yielded a planting with 90 percent mosaic disease. The same man, feeling suspicious of the trouble, purchased tips from a locality where he had previously raised a heavy tonnage of loganberries. These tips were set at some distance from his other yards but with the same exposure and soil conditions. The resulting plants are strong and vigorous with no symptoms of mosaic, although they are

Fig. 7. Black raspberry plant affected with bramble streak (Eastern Blue Stem).

four years old. This illustrates the importance of healthy nursery stock, for on the average there will be about the same percentage of diseased plants in new yards as there was in the parent yard.

As a planting with a few diseased plants grows older, the spreading of the plants toward each other will naturally increase the chances of the transmission of the disease from the affected plants to adjacent healthy ones, and this danger is greatest, of course, where the canes of diseased and healthy plants are trained together or where, as in raspberry plantings, they are set close together in the row.

In the eastern states the common raspberry aphid *(Aphis rubiphila Patch)* has been proved to be an agent in the transmission of mosaic and leaf curl among red raspberries. This is a tiny aphid which is said to cause no direct damage to the plant. We may have this aphid in Oregon, but it has not yet been observed in connection with these diseases in the state. As yet no insect carrier of these diseases has been observed in Oregon although such a sucking insect as leaf hopper may be doing more damage than we are aware.

VARIETIES AFFECTED WITH THESE DISEASES

Time has not permitted close enough observation to determine to any degree the relative resistance and susceptibility to these diseases of the different varieties grown commercially in Oregon. In no section of the country have extended studies been made to determine which varieties are resistant, but it can be said that no varieties of black, red, or purple cane raspberries, loganberries, phenomenal berries, or blackberries which are grown commercially in Oregon have been found entirely free of mosaic. The Evergreen blackberry is rarely found affected. The Munger and Plum Farmer black raspberries lead as commercial varieties in this state. Both have been found badly affected with mosaic (Munger more often than Plum Farmer); but with our present knowledge it cannot be said that one is more resistant than the other.

Fig. 8. The uniform mottling of a leaf characteristic of raspberry bramble streak.

The Cuthbert red raspberry, our one leading commercial variety, is badly affected with mosaic and leaf curl in many plantings, while the Antwerp and Marlboro do not appear to be so commonly diseased, except the Marlboro, in which usually a high percentage of leaf curl is found.

One planting only of black raspberries, the Cumberland, has yet been found affected with bramble streak in Oregon.

According to Rankin, the Herbert variety of red raspberry "stands alone in showing apparent resistance to mosaic. The St. Regis or Ranere is practically never found affected by mosaic. The red variety Donboro has been observed under conditions where for several years the amount of

mosaic has increased until every plant is now affected, but there has been no dwarfing or other effect on the quantity or quality of the fruit in a season favorable to raspberries." Although such a variety might be productive in itself, yet it might also become a very detrimental carrier of mosaic to other brambles near by. The question of resistant varieties as well as the question of what types of brambles may with safety be planted side by side are problems for considerable experimental study.

VARIETIES WHICH HAVE BEEN FOUND AFFECTED BY MOSAIC IN OREGON OR WASHINGTON

Since mosaic is more widely spread in the state than are any of the other diseases mentioned in this connection a list of the varieties affected is included here.

Raspberries—

Black

1. Munger
2. Plum Farmer
3. Black Pearl
4. Kansas (American)
5. Cumberland
6. Hoosier
7. Parker
8. Gregg
9. An improved Munger
10. *Rubus leucodermis,* the common wild black raspberry.

Purple cane

1. Columbian
2. Abundance
3. Royal Purple

Red

1. Cuthbert
2. Antwerp
3. Marlboro
4. Perfection
5. June
6. St. Regis (not badly)

Thimble Berry

1. *Rubus parviflorus*

Wine Berry

1. Japanese wineberry *(Rubus phoenicolasius)*

Blackberry group—

True blackberries

1. Snyder
2. Eldorado
3. Corey's Thornless
4. Stuart (Texas)
5. Himalaya
6. Ohmer
7. Lawton
8. Evergreen *(Rubus laciniatus)*

Logan type

1. Loganberry
2. Phenomenal

Dewberry

1. *Rubus macropetalus,* the common wild trailing blackberry.

CONTROL

For all such systemic diseases as are described in this circular, the measures to be taken for prevention and control are the same.

1. **Roguing of diseased plants.** In plantings where the percentage of any of these diseases is not too high, control may be possible by grubbing out the diseased plants. First, the grower should become familiar with the symptoms of the disease on the varieties of berries in which he is particularly interested and then rogue thoroughly. Every affected plant should be so thoroughly grubbed out that no diseased sprouts will appear from the old root system the next spring. *Success will depend on the accuracy of detecting the symptoms of the disease* and the thoroughness of the roguing. The first roguing is advised in May when symptoms show best. The rogued plants should be carefully removed at once and burned. In eastern states where the raspberry aphid is known to disseminate leaf curl and mosaic, a second roguing is most effectively done the last of July or in August after aphids have been killed by a period of hot weather. Should sucking insects which are capable of carrying the disease be found in western plantings, a helpful means of control will be the elimination of such insects. In plantings where any of these systemic diseases are present to such an extent that elimination by roguing is impractical the only procedure is to grub out the whole planting after it is reduced to a non-profit condition. If it is the hope of the grower to replant to brambles, if would be necessary to plant the land to a crop which may be clean cultivated for at least one year. This clean cultivation should be constant and rigid, and should continue until, by very close observation, no living shoots of the brambles appear.

2. **Use clean nursery stock.** As suggested above these diseases are carried from an old diseased planting to a young planting through the diseased tips or transplants, which are merely a vegetative part of the original diseased plant. *Thus disease-free stock is of the greatest importance. The grower should run no risk in this respect.* If disease-free tips are set in a clean field there is no reason to believe they will not remain clean. Where old infected fields are too near, the control may be more difficult should sucking insects be found to carry the disease. Even under such conditions, however, by vigilant care the young planting will be kept clean by roguing. This will be materially aided by keeping any neighboring, older plantings well rogued. With proper care, therefore, as to disease-free nursery stock and land cleared of all traces of previous plantings of brambles, new yards can be maintained in which mosaic, leaf curl, or streak will be under control or eradicated completely.

3. As a precaution against the spread of mosaic in loganberry and blackberry plantings, it would be a safe procedure to **train the canes** in such a way that the canes of one plant do **not** come **in contact** with those of another plant.

NEED FOR EXPERIMENTAL WORK

Since April of this year, when the presence of these diseases was discovered in Oregon plantings, time has not permitted of more than a hasty survey, which has revealed that the troubles, especially mosaic, are widespread in the western part of the state. Many questions in connection with the spread and control of mosaic of brambles need investigation. For example, the mosaic disease of loganberry is a newly discovered disease for this plant and has rather indistinct symptoms, while the symptoms of red raspberry mosaic are rather distinct from those of black raspberry mosaic. Since many of the mosaic diseases of such annual crop plants as cucumber, potato, tobacco, and tomato may be transmitted to some plants but not to others, the question arises as to whether there may be more than one strain of mosaic disease in brambles. That is, it should be ascertained whether mosaic-free loganberries may be planted near mosaic-infested blackberries, or black or red raspberries, with any degree of safety, or whether they may be planted in any other combined plantings. *What diversity of brambles in close proximity is most advisable?* This question must be answered experimentally!

Another question which has been frequently asked is whether any varieties of brambles have been found immune or resistant to mosaic. Reference was made above to progress along this line in the eastern United States. No varieties, however, have been found which are highly resistant. There is a great need for experimental selection in order to find, if possible, resistant strains of several commercial varieties of black and red raspberries and blackberries and, at least, one resistant strain of loganberry. As far as possible these strains should be selected from varieties which have already been successfully grown and marketed in Oregon. Such selection of resistant strains is very important to the small fruit industry of Oregon, but it cannot give immediate relief where these diseases are already established, since selection necessarily requires a long time.